Notebook, N-00-06-22

Battery
Experiments.

June 22nd 1900.

201

One edge of a regular nickel plate dipped into dissolved gelatine. When dry soaked in dichromate of Potassium and exposed to light for several hours.

The soda at first seems to extract the colour to a certain degree, then dissolve the gelatine (plate being cathode)

#202

Nickel plate partially dipped into a sol of Gelatine in Water and dichromate – exposed to light.

Plate used as cathode exactly same behaviour as #201.

203

Warmed plate partially covered with paraffine. All torn off during a few hours.

203 b

Perforated plate with paraffine

Torn off on one side

Penetrated by Zn.

# 204
Plate with a strip of Schellack

Schellack dissolves and gives foam on top of liquid, colouring yellow.

# 205
Kautchauck dissolved in CS_2
After some hours quite spongy and loos and not pulling preventing deposit of Zn. Perforated plate may work better

# 205 a
On perforated plate.
Gives a little foam, wich afterwards disappears.
on some places penetrated by the Zn.

#206. (Perforated plate)
Edge of plate painted with Kautschuk) in CS_2, dried and soaked in sulphur at ca 130° for 3 hrs then given a few min at 150 – 160°.
Superfluous sulph extracted by boiling soda

Fine after 2 days serving as both poles.

#207
cannot get any sol of Hard rubber in CS_2 strong enough for a coating.

#208
Copal Varnish

#209 Lanoline
Perforated plate
torn off by gas bubbles

210
Pitch in benzol
(coal tar pitch)
Perforated plate

Pitch dissolved quickly

#211
Japan, baked.

Not dissolved but
flakes off
Perforated plate will
give -perhaps- better results
than asphalt in # 197

# 212
Japan on perforated
plate; amalgamated
Flakes off after 4-5 hours

#213
7 different kinds of
asphalt dissolved in
benzol and used on
perforated plates.

214 (a) Cuban
Very brittle, falls off.

315 b) (Pitch)
Forms a loos, soft coating after being partially flaked off by the Zn

316) c) Syrian
Better than previous two, though pieces broken off

317 d.)

318 e)

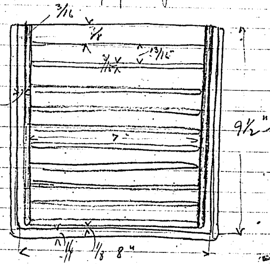
319 f) Trinidad

(820 h) - Left Mexico.

221

Weight of a battery with distance between poles 3/32" and and 1 Amp hour per 3 □" (per 4" nett.)

Cell containing 10 zinc and 11 copper poles


3/16
1/8
13/16
1/16
1/4
7
9½"
1/4
1/8
8"

Surface of one plate = 2 × 9 × 13/16 × 7
= 2×51 = 102"

10 plates 1000 □"

Total amount of Zn
300 AH

Active .. 250 AH

Copper oxide $\frac{250}{65} \cdot 149 = 575$ g [illegible]
(460 g Cu)

Vol of Copper ox : $\frac{0.1465}{7} \times 600 = 12.7"$

per grid: $\frac{12.7}{11} = 1.15$

Thickness $\frac{1.15}{7 \times 9} = 0.0183$

$+ 2 \times 5/1000 = 28/1000$

Breadth of Cell:

$10 \times 3/16 + 11 \cdot \frac{28.3}{1000} + 3/16 = 2.37 = \underline{\underline{2\,3/8"}}$

Weight of Zn (25% to stay in sol.)

$1.25 \times 300 \times 1.224 = 460$ g

10 plates 5/1000 : $10 \times 9\frac{1}{2} \times 8 \times 5/1000$
= 3.8 cub in or 448 g

Nickel in grids
2 × 11 × 8 × 9½ · 5/1000 = 8.40 cub in
or 1000 g.

Mercury : 2 × 300 = 600 g
Vol of " 2.3 cub in

Vol. of jar : 190 cub in

Plates :	3.8
Grids	8.4
Copper	3.35
Mercury	2.20
	17.85

Val of Soda : 172 cub in
or 2.82 l weighing 3650 g

Weight of jar 1600 g

1 Amp per 10 lb

Weight:

Zn	460	
Plates	448	
Mercury	600	
Allowance	400	
Zinc pole		1908 g
Copper ox	575	
Brits	1000	
Allowance	400	
Copper pole		1975 g
Soda	3650	
Jar	1600	
		5250 g
Total		9133 g
or	17.1 lbs	

per Amp hours $\frac{17.1}{250} = 0.0685$

Res. Amp hour per lbs:

$$\frac{250 \times 0.67}{17.1} = 9.8$$

Lead acc: 4.5 - 3.0 - 4.8 - 5.5 - 6.3 - 6.8 -

Theoretical cell:
Hg in Carbon – [illegible]
Cd in carbon

The porous carbon plates take up their own weight of Water and weigh per 100 cm² of a 1/8" thick plate 13.12 g. Vol = 31.75 cc.

Cd per 1 AH 2.1 g; ~~1 VAH~~
Hg " 1 " 3.75 g

The cell gives .84 Volt.
Cd per 1 VAH 2.7 g ×
Hg " " 1 VAH 4.46 g ×

6HPH = 4470 Watt hours
Cd per 6HPH 12.07 kg ×
Hg " " " 20.77 " ×
Weight of Carbon $\frac{12.07}{4}$ being 1/4 of Wgt
Cadmium " " 3.02 kg
Area of Carbon $\frac{3020}{13.12}$ = 230 dm²
Vol of Plates $\overset{13.2}{31.75}$ · 230 = 7302 cc
Vol of Solution 3657 "
Weight of Sol 4.75 kg ×
40.61 kg = 90 lbs

Cd is not absolutely insoluble in Soda & Potash and will consequently slowly dissolve out of the pores and plate back on the surface of the Cadmium-pole - carbon plate (a bad bug)

Iron instead of Cadmium

Theoret. voltage

Obtained .86

Weight per 6 HPH.

$$\frac{12.07 \cdot 0.9}{0.8} \cdot \frac{56}{112} = 6.8 \text{Kg}$$

6.8 kg = 15 lbs

Salts for mixing with the Carbon to give porosity

Phosphate of Magnesia

Phosphate of Barium
Beautiful, Ideal for the purpose - except that it is completely insoluble and cannot be removed.

Phosphate of Strontium
Good - eats out during 10 hours in Hcl.

Borate of Magnesia
Powders poorly and does
not mix well

Borate of Lime

Borate of Strontia

Borate of Barium

Fluoride Magnesia
Sticks together

Fluoride of Lime

"

Fluoride of Strontia

"

Fluoride of Barium

"

Prussian blue

Barium Ferrocyanide

Lead Ferrocyanide
Very fine

Manganous Ferrocyanide

Stannous Ferrocyanide

Phosphate of Tin

Phosphate of Lead

Borate of Tin

Borate of Lead

Sulphide Calcium

Manganous Sulphide

Strontium Sulphide

Manganate Barium

Manganate Strontium

Manganate Calcium

The best results are obtained by saturating a solution of amm. chloride Carbonate or Axalate at ~~[illegible]~~ ca. 80° C and cooling in freezing mixt, stirring well.

Carbonate gives fine little crystals, that grow during drying

To prevent this we wash with alcohol

Oxalate Amm gives beautiful needles only a few 1/1000" thick and some 50/100" long.

Chloride Amm behaves nearly like the Carbonate.

1 5/16 × 3
5" × 1/8"

The second Cadmium cell has 6 Copper plates
2 3/8 × 1 5/16 × 1/8
Total weight Copper:–

Cadmium Grid is built on Frame of square tube and has plane surfaces.
The three sections hold in all 153.6 g moist Cd.
Weight of Grid 36.4 g
Cd is cleaned w. H_2SO_4 before Packing and packed very hard.

The cell was discharged the first time through same resistance as used for first pattern (ca .75 Ohm) and gave .25 A. This kept up for days and gave in all 32.4 AH (153.6 g Cd_2O ought to give 36.5 AH)
The copper plates used were black; oxidized at red heat.

Copper then reduced all down by current and cell

$\frac{.03}{0.5} = 0.06$

charges at 2, 1.5 & 1 Amps.
in all 22 AH.
Then gives gass at Cd pole
even for small currents.

Discharges through menti-
oned resistance. Current at
start: .46

8.30	.46A	E	e				
9.00	.47	40	37	10.00	4.8		
10.00	.48.			11	48		
11.00	48			12	47.5		
12	48.5			1	4.75		
1	48.5			2.	48		
2	49	41	38	3	48		
3	49			4	48		
4	49			5	47		
5	49			6.	47		
6	49			7.	47		
7	49.			8.	47.		
8.	48	40	37.2	9	47		
9.	.485			10	47	40	36
10.	48			11	47.		
11.	.48			12	47.		
8.30	4	45		1230 off			
8.35	485	40	38	9.00	47		
9.00	.47			10.00	47.		

	47			
11	47			
12	47			
1	47			
2	47	38.5	35.5	
3	46			
4	45			
5	45.5			
6	45.5	38.5	35.5	ca 19½
7	45.5			
8	45.5			
9	45			
10	45			
11	44.5			
12	44.5			32-22
Monday				
815	— —	—		
9.00	44^{33}			
10	44			
11	43			
12	42.5			
1	41,5			
2	40			
3	35	→ 23,58 AH		
4	12			

13

Charging:

5.00 pm, Monday Nov 19. '00

5.00	2 A	6½	17⅔ AH
-11.30	2		
(20/11) 8.20	2	2⅓	
10.40	1		
	6 pm	Saving	6.⅓
Total			24 AH.

Nov 20 '00

New grid for Cd

2 1/4" by 1 3/8" by 1/8"

Weight 9.7 g

Loaded 37.0 g

Cadmium 27.3 g

6 am	0.3			3	41	
6:30	0.43	.42	33.1	4	40	out
7	0.37		29	11	42	
8	.37			12	42	
9	.42			1	41	
10	42			2	40	
11	43	.425		3	36	
8	42			4	38	
9	43			5	39	
10	43			.6	40	
11	43			.7	42	
12	44			8	40	
1	44			9	42	
2	44			10	39	
3	43.5			11	39	
4	43.5			12	39	
5	43.5			1	36	
6	43			9 am	~~25~~	
7	43			10	24	
8	43			11	26	
9	43			12	25	
10	43			1	7	
11	43				23.34	
12	43					
1 a.m	42.5	.52				
2	41					

Sent charge cell from external source 1.5A in discharging direction

7.5 7.5
3.25 3.5
11.25 10.5

Charge at 10 am Nov. 24/02

10 am 2 Amps. } 13 AH.
5 2 pm off
8.45 — 1.5 Amps } 11.~~25~~
4.45 — 1.5 out —

Total Charge 24 AH.

26/11	~~6.00p~~	Discharge.					
6.00p	25	48	21	7.00	44.5	38	34.5
7.30	38		30	8	45	37	34.5
8.0	37			9.00	44.5	37	34.5
9	40	30	32.1	10.00	44.5	37	34.5
10	40		32	11.00	44.5	37	34.1
(10.15)	(45)	(40)	(35)	12	44	36	34.
11	45	39.5	34.8	1	43	36	33
—				2.20	43	35.5	32.3
9	43	38	34	—			
10	43	37.5	34.5	10.00	43	36	33
11	44	38.5	35	11.00	42.5	37	33
12	44.5	38	35	12	42	36	33.5
1	44.5	38	35	1	42.5		
2	45	38	35.3	2	42.5		
3	45	38	35	3	42		
4	45	38	35	4	41.5		
5	45	38	35	5	40		
6	45			6	39		
	1038				1029		

7.45 38
900 37
1000 35
1100 32
1200 25
15.7_2

1038
1029
157
22.24

22.24 AH.

Charge at 25 Amps. 9.00 am 30 Nov.
8.55 ~~25~~ Amps
2 55 2.5 Acid tell 5. } 15.
4.00 1 Amps
10.30 1 Amps } 8
12.00 p 1 Amps
8.55 a 1 Amps 0.5
925 1 A.
Total charge 23½ AH

Dec 3

9.30 am	[illegible]
10	
11.	37
12	37
1	39
2	39.5
3	40
4	40
5	40.5
6	40.5
7	41
8	41
12	37.5
8	37.5
11	35.
12	32
1	38
4	39
6	39
9	39
11	38.5
12	39
9	37.
11	37.5
2	35
4	34.5

6.	25
8	25
10	12

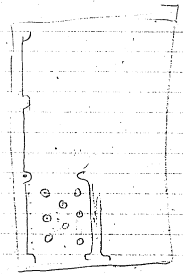
Ch

Charging: Dec 5 '00

11 a.m.	2.5 A	3/4 H [illegible]
6.00 .	2.5	
6.00	1. A.	2

8 p.m. . 2 HA Discharge at 2.5 A.

10.30	47		
11.	37		
12.	38	35V	
1.30	36	34	39
5.00	39	35.9	40
9.00	39		
12	45		
8.30	44.5		
10.30	40		
12	41.5		
6	40.		
10	43		
12	35.		
8.30	34		
12	34		
3	30		
6	21		
9	14		
11	1		



HgO-KOH-Fe - Cell

22 Cells 16 plates 1/4" thick
1/8" apart, Size 4"×8".

Experimental Plates: 2.81 sq in
and 5/32" thick
hold 15 g Hg metallic and
3 g Fe metallic

Proportion of Plates

$$\frac{2.81 \cdot 5/32}{4 \times 8 \times 1/4} = \frac{1}{18.2} = .0549$$

Mercury in one Plate:
15 · 18.2 = 273 g Hg
In 8×22 Plates (176 Plates)
48 kg = 110 lbs
Iron in one Plate: 3 · 18.2 = 54.6 g; In 176 Plates: 9.6 Kg = 21.2 lb
Weight of 1 Carbon plate = 18.2 · 4.8
= 87.4 g. Of 176 Plates 15.35 Kg
= 33.8 lbs

Weight of 1176 Hg Elements

Hg	110
Carbon	33.8
	= 143.8 lbs.

Of Fe Elements	21.2
Carbon	33.8
	55.0

Oxygen = $\frac{16}{72} \cdot 21.2$ = 4.7 lb

Size of Cell:

4½ × 6 3/8 × 9 = 258 cu in.

= 16.4 · 258/1000 = 4.23 l

Vol of one Plate =

4 × 8 × 1/4 = 8 cub in.

Of 16 128 cub in = 2.1 l

Vol of Solution = 4.23 − 2.1 = 2.13 l

Weight of 20% Sol - 1.2 · 2.13 =

= 2.55 kg = 5.73 lbs

Weight of Hg Element	143.8
Fe Elem	59.7
22 Cells 20% Solution 5.73·22	126.0
	329.8

36
176

Discharge small plate
at 1/2 Amp
Taking
Large plate: .9.1
Battery 72.8

Capacity of Battery:

Small plate	2AH
Large "	36.4 AH
Battery	6400 AH
At 0.9 V	5760 VAH
=	7.73 HPH

Test of Automobile battery.

Battery charged acc. to rule
(till 110 V & 8 Amps)

Discharge:

8.35 –	25 Amps –	95 V open	87.5 V
9 05 –	20.3	90.2	85
9	25	–	84
9 35	23	87.5	82
	20	?	82.2
10.05	18.3	78	73
	20		72
1075	18.	78	72

79.2

AH: 36.060

Work: 3.96 HPH.

Charge:

1048 pm	19.6 A	96 V
11.04.	18	99.5
	20.4	100
1127	18.7	101.2
	20.5	102
11.50	20.5	104.4
1215	18.2	109
	20	110
12.35	17	112
105	8	108

40.16 AH
Total Work 4100 AH = 5.5 HPH

Open Circuit: 97.5 (2.2)

Discharge:		e	E	R
2.30 pm	16.75 A	87.6		0.233
2 55	15.4	87.5	91	
3 10	15	87	90.4	0.27
3 25	15	868	90	0.213
3 40	15	86	89.5	
3 55	15	85	89	
4.10	15	84.5	88	
4 25	15	835	87	
4 40	15	818	88	
(448)	(15)	(78)	(83)	0.28
4 55	15	75.7	80.5	
(5.00)	(15)	75.2	80	
(505)	(15)	74.8	79.2	
510	(15)	73.8	79	

40.5 AH.
Average Voltage 79.7 V
3230 WH = 4.34 Hp

Internal Resist.: 0.233
per Cell 0.0053

Charged at 10 Amps till
voltage reached 110-112 V-

Discharged at 15 Amps.

			94.2 open
1.25 pm	16.9 A	89 V.	
1.40	16	88.5	91.7 V open
1.55	15.4	88.1	91.3
2.10	15.1	87.9	90.8
25	14.9	87.4	90.3
40	15	87	90
55	15	86.4	89.6
3.10	15.1	85.6	89
25	15.1	85	88
40	15	83.9	87
55	15	82	85.7
4.10	15	80.6	84.5
4.25	~~15~~	76.6	82
4.37	~~15~~	71.2	78.5

47.5 AH av V. = 80 V.

Work = 3800 WH = 4.56 HP-H

Measurements on the
windings of the motor

Armature terminals:
50 amps, 7.3 volt
Resistance: .146

Field terminals.
50 amps 4.2 V. R = .084

Armature, one brush segm
50 amps. 6.5 V R = 0.13
Diff = 0.016 w (one brush

Pole brushes; stops: 3.2 V
turning 3.7 V.

20.2 Amps
R =

Efficiency at 32 Amps
92 %

Weight of repaired batteries:
4 × 227 =
of old set:
4 × 2

Weight of Motor	311 lbs
Total " Vehicle	2610 lb
whereof on front Wheels	770
" rear "	1870
	2610

5/5

a) B I.

Oxide Storage battery: 75 AH

Charged to 10 Amps. 2.6 V.

	J	e	E	t			
Open			2.11	5.00	405	188	197
9.00	5.5			6.00	38	185.5	[illegible]
930	53.4	2.00	2.075	6.30	33	185	194
10 00	52.5	2.01	2.075	8.00	48	177	190
11.00	50.4	2.00	20.7	9.00	23	180	180
1130	48.6	1.99	20.65	930	55	184	183
1200	48	1.985	2060	1030.	31	138	128
12.30	48	198	206				
1.00	47.2	197.5	2055				
130	47	197	205				
2.00	50	196.5	205				
2 30	49	196	2045				
3.00	42	196	204				
Open			208				
10.45	48.8	197.5					
11.00	45	195	204				
11 30	435	195	203				
12	55 44	1945	202				
	57.5						
1	52.5	191	201				
2	44	191	201				
3	44.2	190	198				
4	50.5 44.2	187					

75.44 AH

4.81

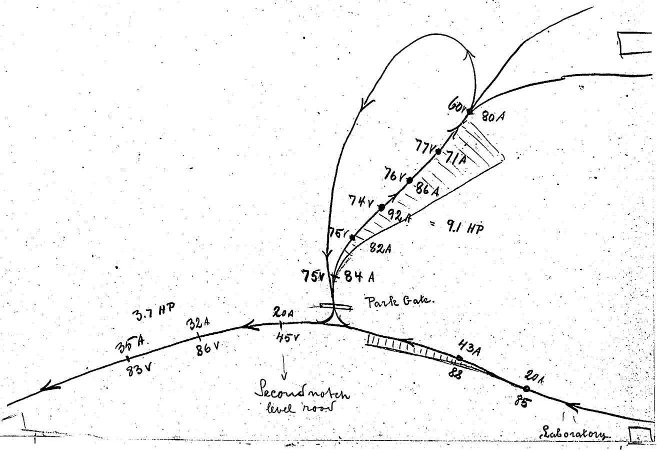
55.71

33

86

43

[ITEM FOUND IN BOOK]


60v
80A
77v
71A
76v
86A
74v
92A
= 9.1 HP
75v
82A
75v
84 A
Park Gate.
3.7 HP
32A
20A
35A
86v
45v
83v
43A
88
20A
85
Second notch
level road
Laboratory

[ITEM FOUND IN BOOK]

Running:

	D	V
First notch	7.5	22.8
Second	8	44.8
Third one wheel	8	22.5
Reverse	7.6	225

1275

[ITEM FOUND IN BOOK]

R.

~~70 0.00.25~~

0.0.2

$$R = \frac{0.076 \cdot e}{q} ; = \frac{0.076 \cdot 0.1265}{3.230} = 0.00265$$

0.003

$$q = \frac{5}{1000} \times 1 \times 25.4^2 = 323 \text{ mm}^2$$

645

6000

Resistance = 0.00265 Ohm

7.89.05

0.016

0.1265

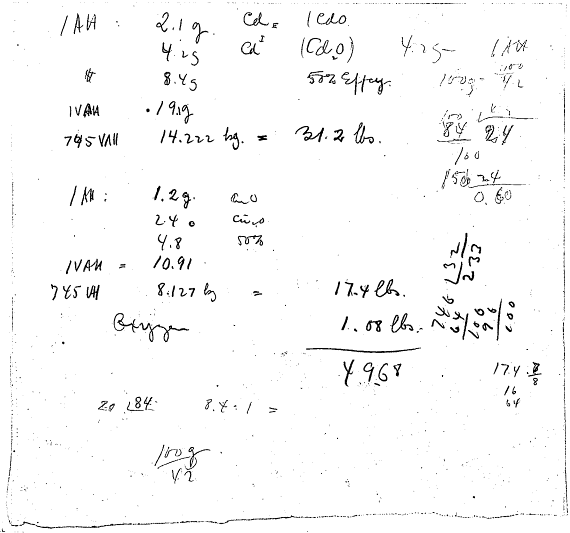
Drop at 50 Amps.

$$= 50 \cdot 0.00265 = 0.1325 \text{ V}$$

Current per sq mm: $\frac{50}{5/1000} = \underline{\underline{10000}}$

1.1 20

[ITEM FOUND IN BOOK]



1 AH : 2.1 g. Cd$_E$ 1 CdO

4.25 Cd^I (Cd$_2$O) 4.25 — 1 AH

8.45 50% Effcy. 100g - $\frac{100}{4.2}$

1 VAH .19.1 g

745 VAH 14.222 kg. = 31.2 lbs.

$\frac{100}{84}$ 24

100

150 24

0.60

1 AH : 1.2 g. CuO

2.4 Cu$_2$O

4.8 50%

1 VAH = 10.91

745 VH 8.127 kg = 17.4 lbs.

Oxygen 1.08 lbs.

4.968

17.4 $\frac{8}{8}$

16

64

20 84 8.4 : 1 =

$\frac{100g}{4.2}$

[ITEM FOUND IN BOOK]

Kennelly,	Standard
5,	4.62
10,	96,
15	13.4, 8

Reduction : {0.98

[ITEM FOUND IN BOOK]

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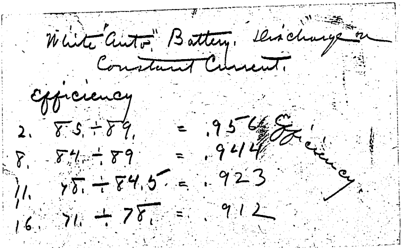

White "Auto" Battery. Discharge on Constant Current.

Efficiency

2. 85. ÷ 89. = .956

8. 84. ÷ 89 = .944

11. 78. ÷ 84.5 = .923

16. 71. ÷ 78. = .912

Efficiency.